



Software defined Testbed



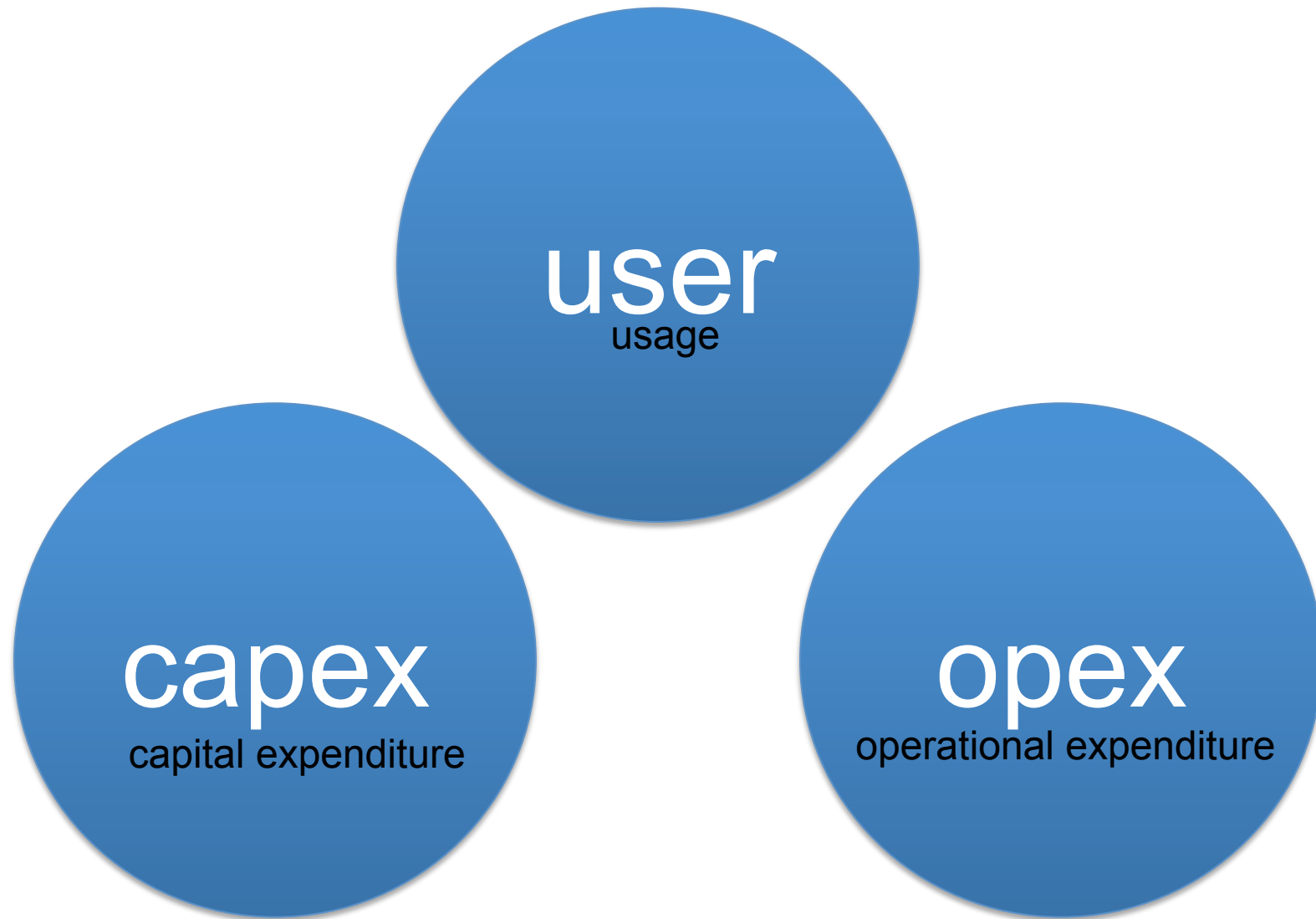
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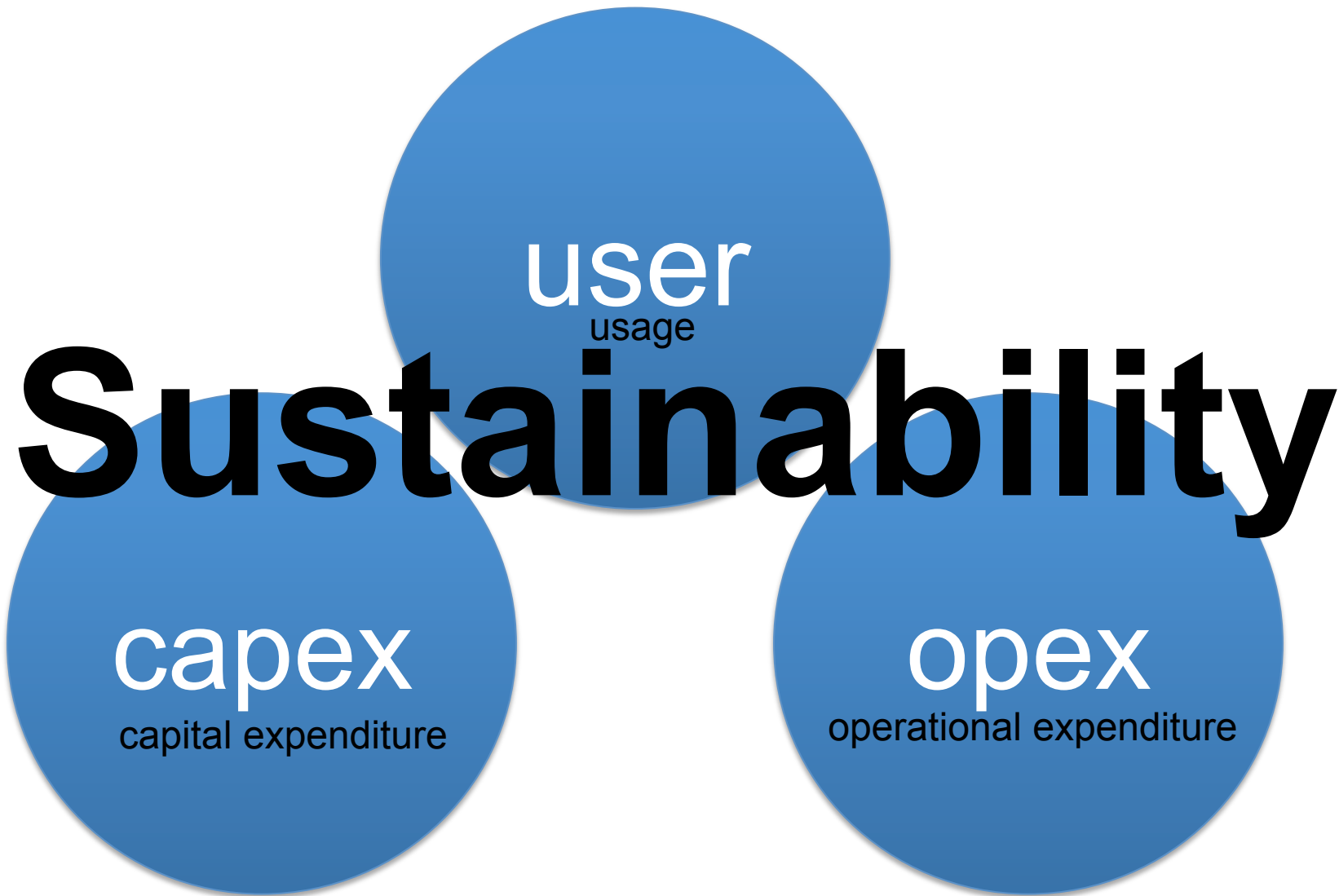


The critical triangle





The critical triangle

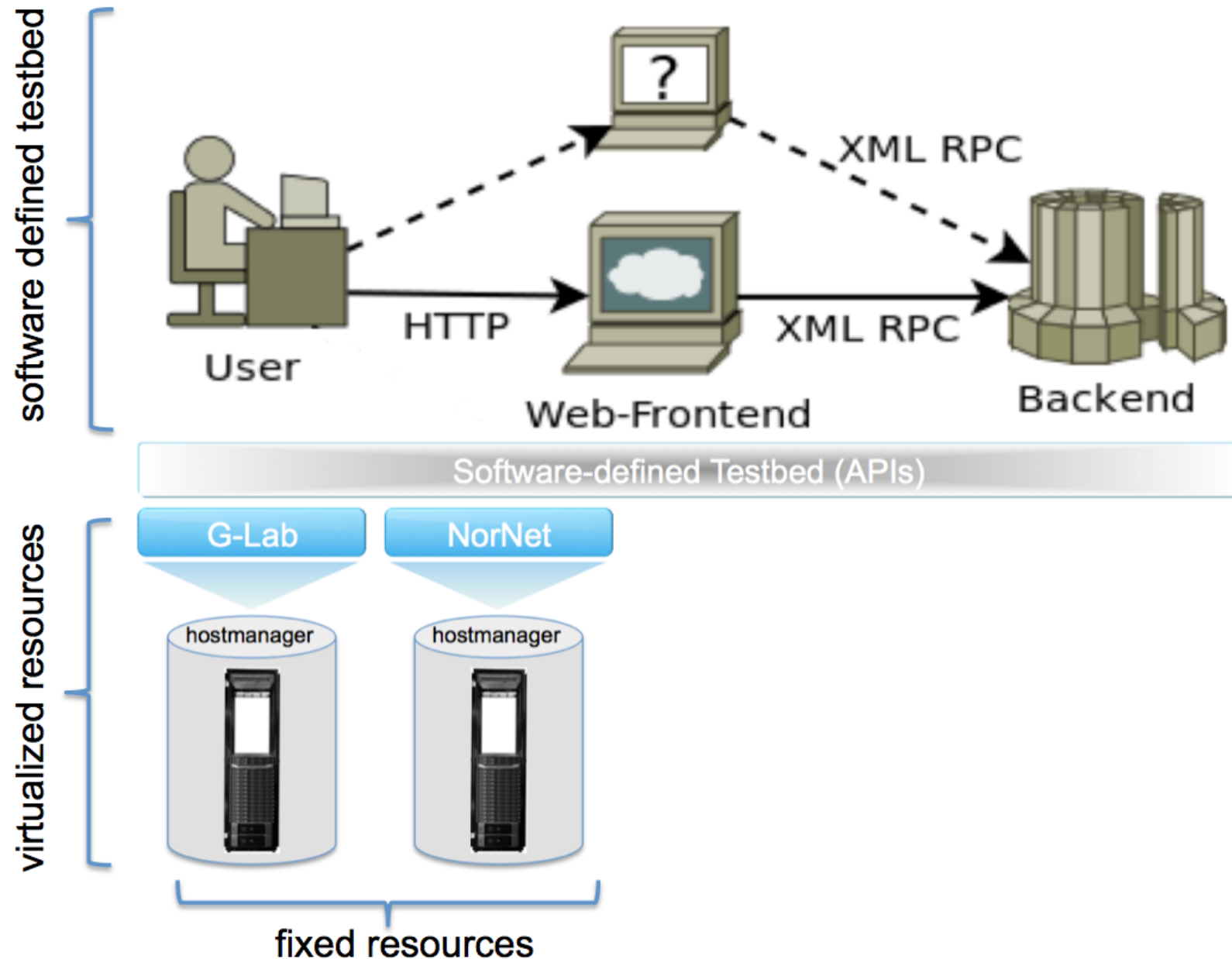




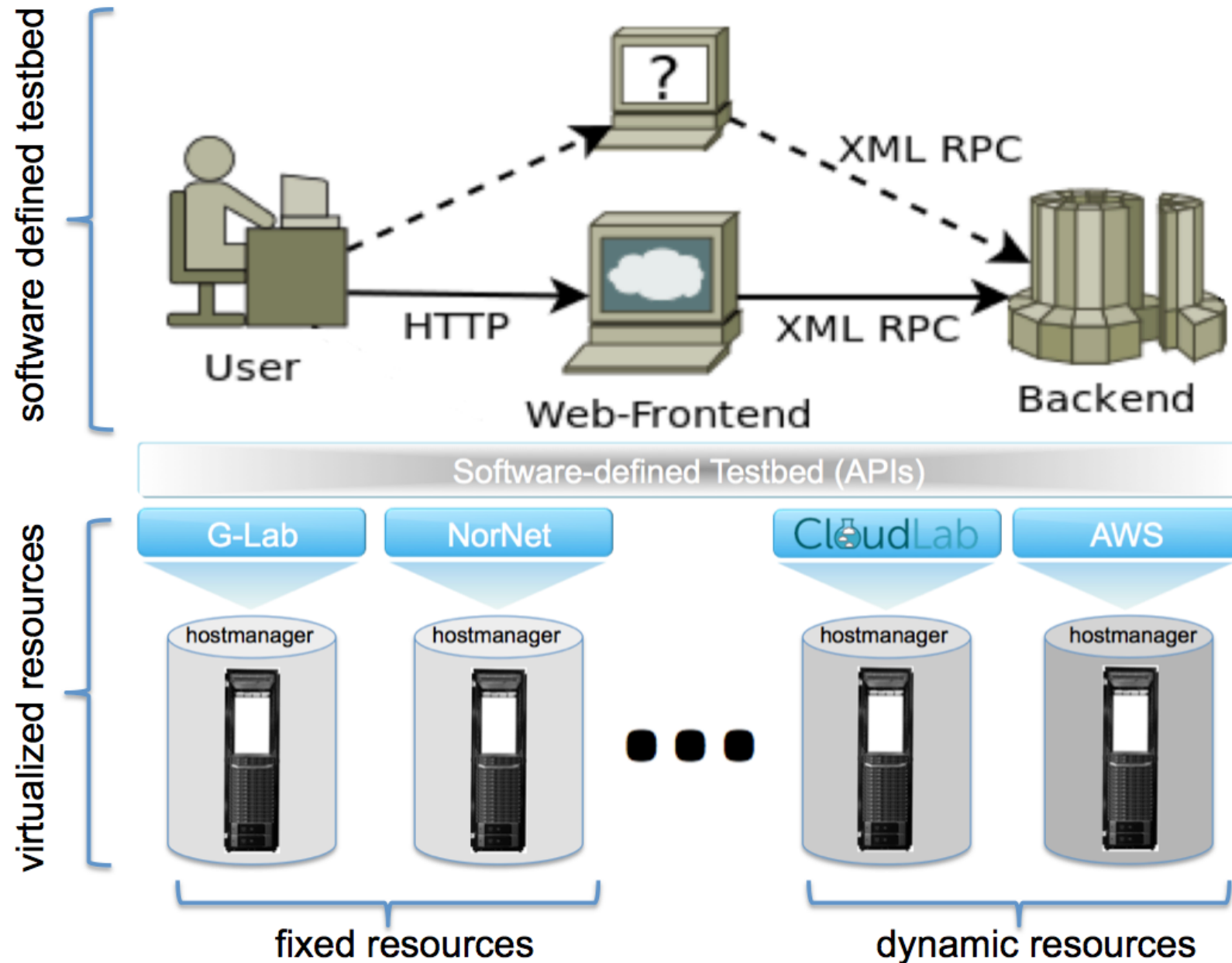
The findings ...

- ▶ Most testbeds today are a research effort in itself
 - Less attractive to the end user (non CS)
- ▶ Testbed on demand
 - Depends on the experiment itself
 - It must be easy to use also for domain scientists **not** from CS
 - A testbed independent of the operational network
- ▶ Comparable to
 - Astronomers with big telescopes which must be shared
 - Physicists with their collider infrastructure (CERN / LHC)
 - ...
- ▶ To do
 - Offer an infrastructure (the facility hosts) like the Géant network
 - Include offers from cloud providers
 - bare metal machines / virtual machines
 - Create a software defined testbed which can easily federate

The architecture



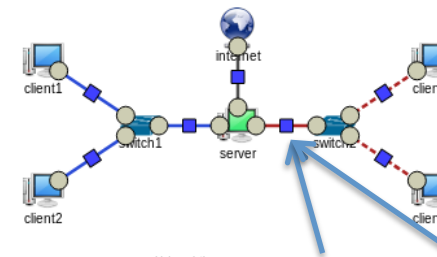
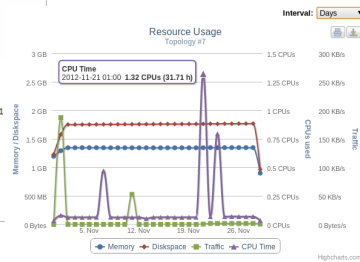
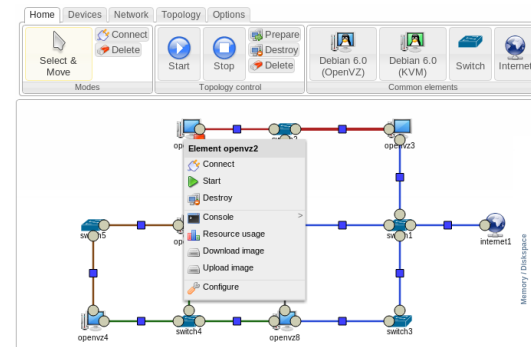
The architecture





T_oMaTo – Editor and Features

- ▶ **T_oMaTo** graphical editor
 - Creating topologies by drag/drop
 - Connects topologies
 - Resource usage per topology
- ▶ **Topologies**
 - Colored icons show virtualization technology (KVM, OpenVZ,...)
 - Linux and Windows OS
 - Link style shows link attributes
 - Complex topologies (multi-homing)
- ▶ **On link basis properties**
 - Bandwidth, Latency, Jitter, ...
 - Packet capturing (Cloudshark)
- ▶ **Console access**
 - HTML5, Java applet



Link emulation
Enabled ☒

Direction
From openvz1.eth0 to tnc_vpn5.tnc_endpoint6
From tnc_vpn5.tnc_endpoint6 to openvz1.eth0

Bandwidth 10000 10000 kbit/s

Delay 0 0 ms

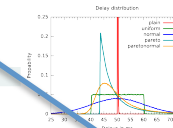
Jitter 0 0 ms

Distribution Uniform Uniform

Loss ratio 0 0 %

Duplication ratio 0 0 %

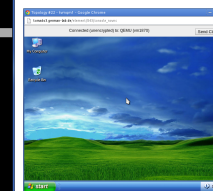
Corruption ratio 0 0 %



```

top - 11:16:52 up 0 min, 0 users, load average: 0.05, 0.01, 0.00
tasks: 2 total, 1 running, 0 sleeping, 0 stopped, 0 zombie
Cpu(s): 0.8ss, 0.8sy, 0.8ni, 1.898 id, 0.8aw, 0.8hi, 0.8si, 0.8st
Mem: 554288k total, 5788k used, 514588k free, 0k buffers
Swap: 554288k total, 0k used, 554288k free, 0k cached

  PID USER      PR  NI  VIRT  RES  SHR  S CPU% MEM%   TIME+  COMMAND
    1 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 init
    2 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 kthreadd/436
    3 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 kthreadd/436
   14 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 init-logd
  245 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 maillogd
  231 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 cron
  240 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 sshd
  249 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 bash
  250 root        0   0    0     0   0   0   S   0.0  0.0   0:00.00 top
  
```





Scaling up

▶ Single-host deployment

- Hostmanager, Backend and Web-Frontend can run on the same host
- Easy for local tests


▶ Isolated multi-host setups

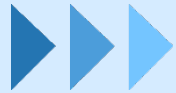
- Running multiple hosts with a single backend and web-frontend on user premises
- Isolated infrastructure for SMEs

▶ Federated setups

-  **ToMaTo** hosts can be used by multiple backends
- The  **ToMaTo** community consists of over 100 hosts at several sites

▶ Testbed on demand


- Dynamically allocate cloud resources for experiments
- Current research effort
 - Master thesis on allocating resources from CloudLab for  **ToMaTo**
 - Master theses on allocating resources from AWS
 - Bachelor thesis on dynamic host (VMs) allocation



Summary

- ▶ **What should future fixed networking testbeds offer**
 - Less capex and opex
 - Cover a broad area of applicability
 - Independent of the operational network

- ▶ **and how can they attract users?**
 - Easy to use especially for scientists NOT from CS
 - Pay per use
 - Easy adaptation to research questions

- ▶ ** MaTo Testbed on demand**
 - Depends on the experiment itself
 - A testbed independent of the operational network
 - Each topology runs in its own VPN
 - Independent of the operational network
 - On demand integrating of Infrastructure
 - CloudLab, Amazon, Google,...
 - bare metal machines / virtual machines
 - Create a software defined testbed which can easily federate



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Questions?





Literature

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- ▶ *Dennis Schwerdel, Daniel Günther, Robert Henjes, Bernd Reuther, Paul Müller: **German-Lab Experimental Facility**, Future Internet - FIS 2010, Lecture Notes in Computer Science, 6369, 2010.*
- ▶ *Dennis Schwerdel, Bernd Reuther, Thomas Zinner, Paul Müller and Phuoc Tran-Gia, **Future Internet research and experimentation: The G-Lab approach**, Computer Networks, January 2014, ISSN 1389-1286.*
- ▶ *Paul Müller, Dennis Schwerdel and Justin Cappos, **ToMaTo a Virtual Research Environment for Large Scale Distributed Systems Research**, PIK - Praxis der Informationsverarbeitung und Kommunikation, 2014.*
- ▶ *Dennis Schwerdel, David Hock, Daniel Günther, Bernd Reuther, Paul Müller and Phuoc Tran-Gia, **ToMaTo - a network experimentation tool**, 7th International ICST Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TridentCom 2011), Shanghai, China, April 2011.*